What I did to Adol-C and ISSM

Utke/Larour

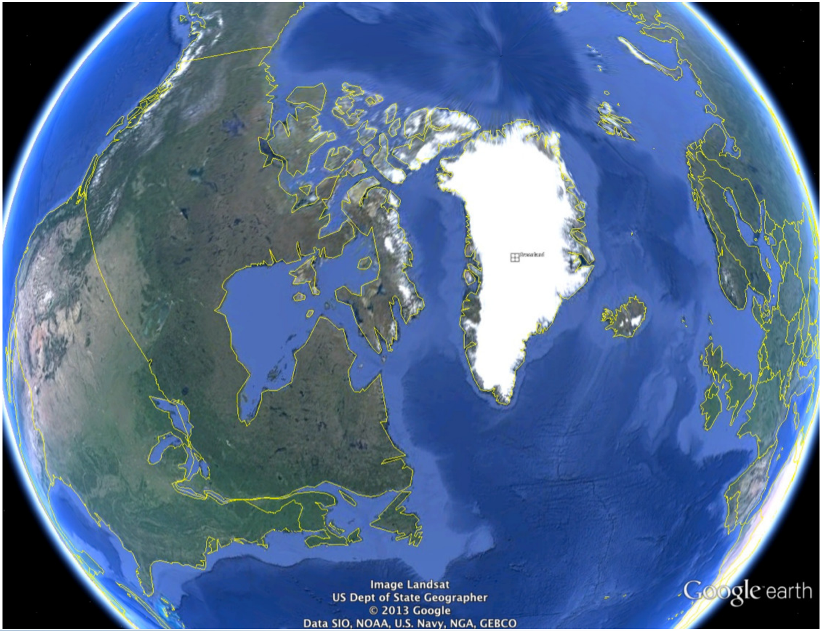
Argonne National Laboratory
Jet Propulsion Laboratory

EuroAD - Dec/2013 Oxford, UK

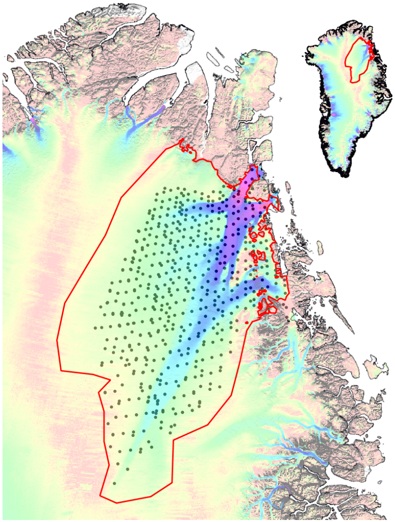
outline

- what this is for
- changes in ISSM
- changes in Adol-C
- external solvers
- adjoinable MPI
- performance

Greenland

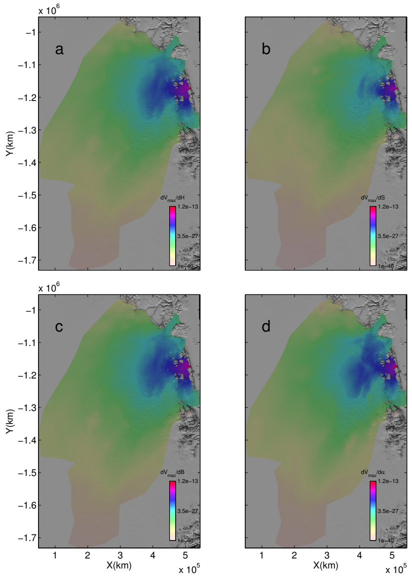

Greenland
Image Landsat
US Dept of State Geographer
© 2013 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

the North-Eastern Ice Stream on Greenland



- velocity field
- red boundary shows domain of interest
- dots indicate observation data
- surface observations by satellite/stations
- drilling holes is expensive
- goal is model tuning for prediction of sea level rise

sensitivity studies - maximal velocity with respect to



- a: H - ice thickness
- b: S - surface elevation
- c: B - bed elevation
- d: α - friction coefficient

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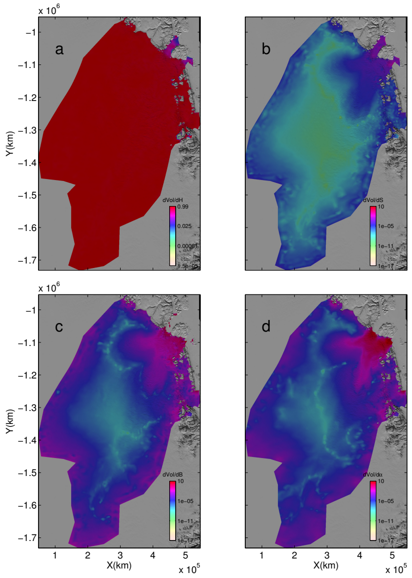

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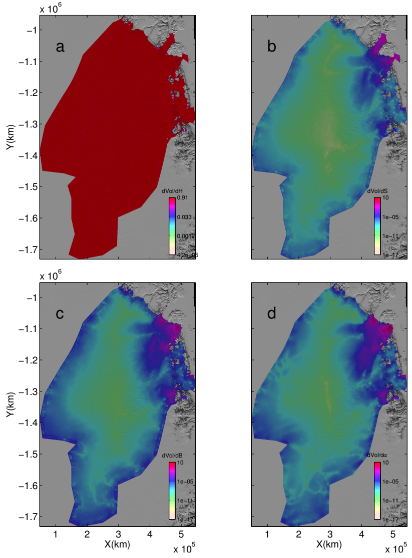
sensitivity studies (last week) - volume with respect to



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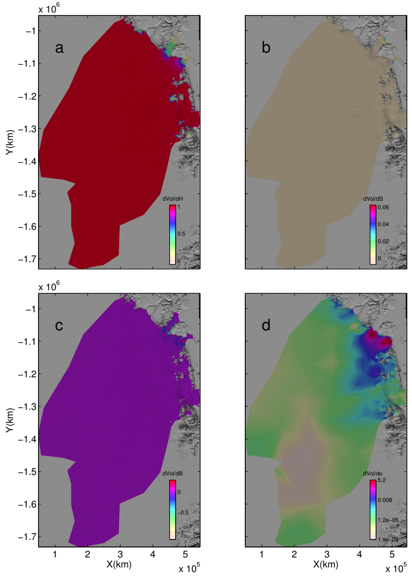
compared to earlier studies ran in higher resolution on Pleiades for longer model time

sensitivity studies - volume above floatation with respect to



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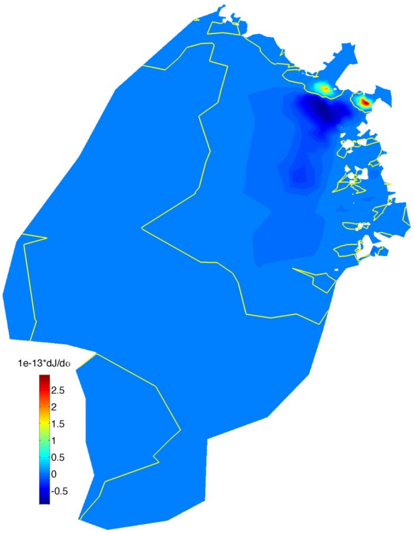
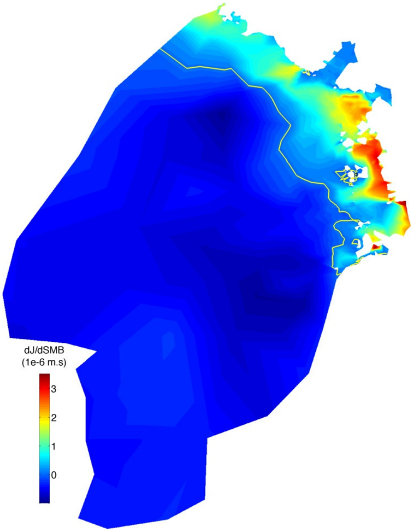
model-to-observation misfit of S to internal state



- with respect to friction coefficients
- L^2 integrated over time
- yellow lines indicate gradient sign switch
- part of an gradient $\rightarrow$ line search optimization loop

model-to-observation misfit of S to external boundary



- with respect to snow-mass-balance
- snow fall given as (external) reanalysis of climate model runs
- hints at less snow fall on the coast, more inland
- means to adapt reanalysis if one assumes the ice sheet model is “correct”

presented at AGU meeting

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- uses libraries (meshing, partitioning, solvers)

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- `reCast` injections represent majority of the manual adaptation work

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- got first regression tests passing with matching forward & reverse derivatives

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- overhead?

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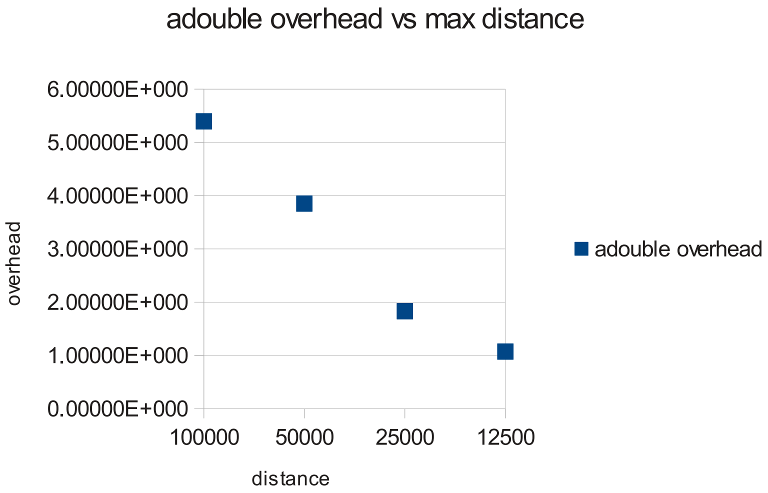

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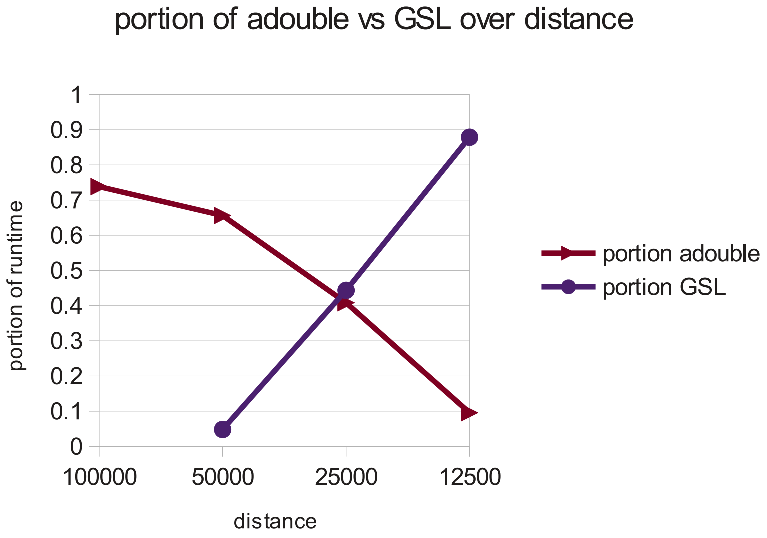

AdolC-ified ISSM performance - tracing & reverse (1)

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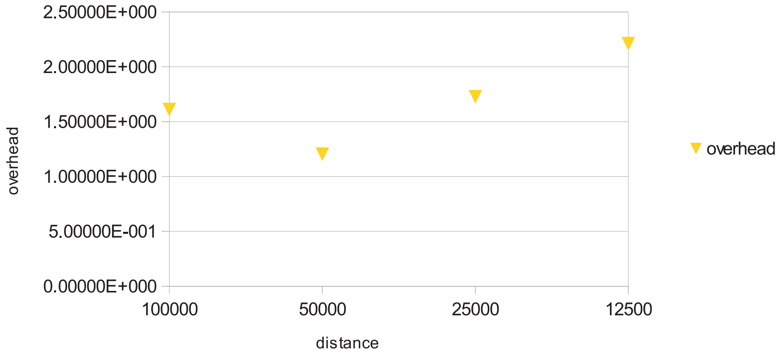
overhead of tracing and fos_reverse over adouble run



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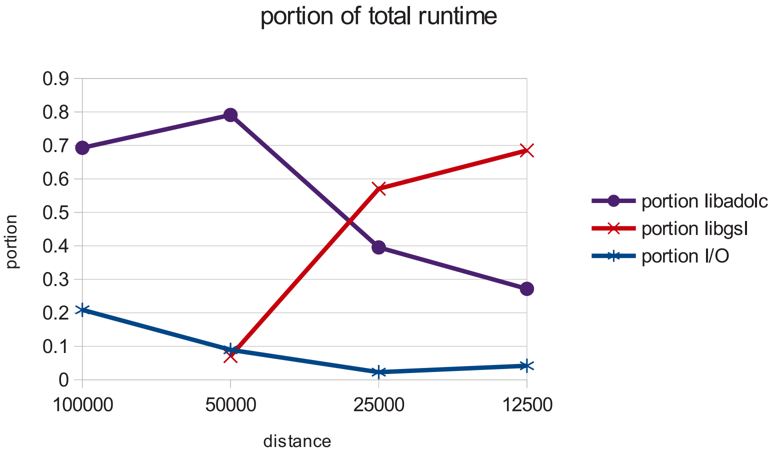

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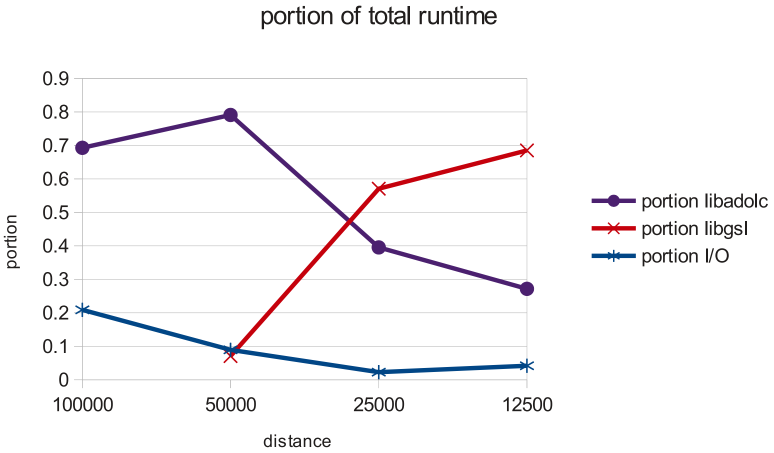

heavily skewed in Adol-C's advantage because of GSL

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- requires contiguous locations $\Longrightarrow$ enforced in `xNew` spec.

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- buffers passed by `void*`
- forces some external distinction of activity

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- practical problems with collectives distributed in the code proved it is easy to get wrong

Adjoinable MPI in Adol-C and ISSM (2)

template the MPI logic with 2 parameters like this pattern

```cpp
#include <iostream>
typedef int DataType;
class TypeInfo {
public:
  static DataType ourDoubleType;
  static DataType ourIntType;
};
DataType TypeInfo::ourDoubleType;
DataType TypeInfo::ourIntType;

template <class T, DataType *typeOfT_p> class C {
public:
  C(){};
  ~C(){};
  void foo(T aT) { std::cout << aT << "␣of␣type␣" << *typeOfT_p << std::endl; }
};

int main (void) {
  TypeInfo::ourDoubleType=1;
  TypeInfo::ourIntType=2;
  C<double,&TypeInfo::ourDoubleType>().foo(2.0);
  C<int,&TypeInfo::ourIntType>().foo(-1);
  return 0;
}
```

not completed (yet) in ISSM

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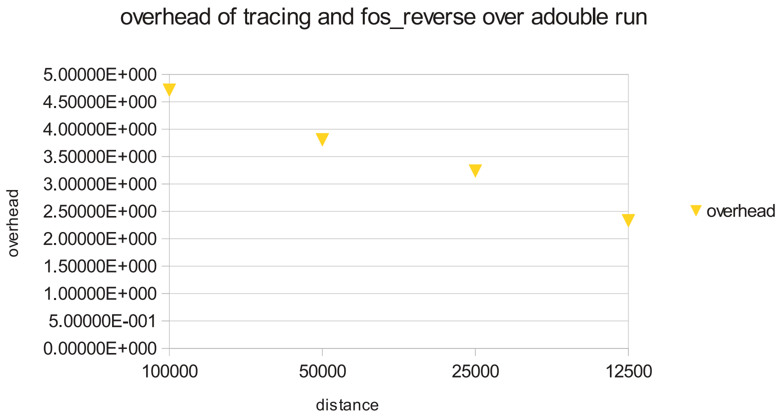
- revisit performance (by now $>$ 500 svn changesets later)

AdolC-ified ISSM performance - tracing & reverse (1)

test3019 - with contiguous locations, 3-way parallel MUMPS



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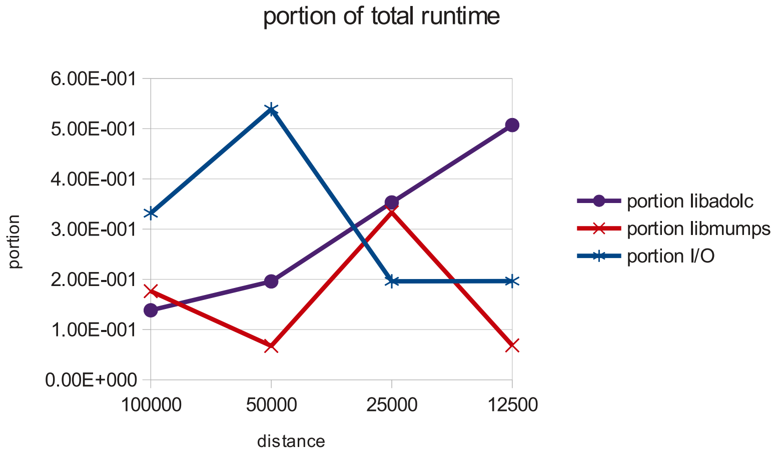

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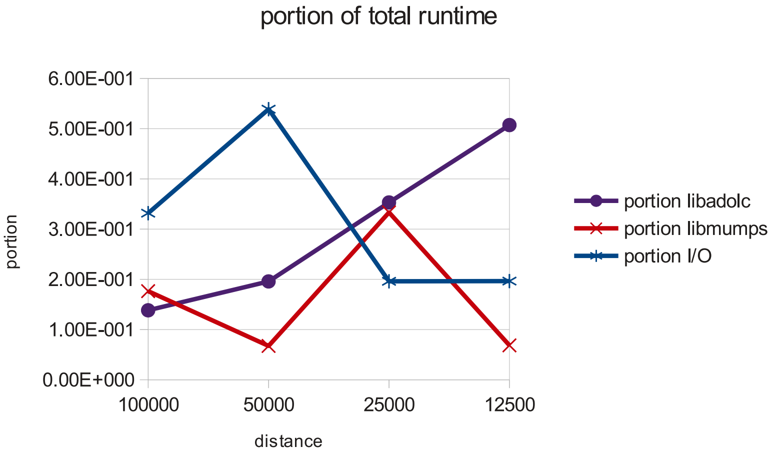

MUMPS is fast - more realistic picture

AdolC-ified ISSM performance - tracing & reverse (3)

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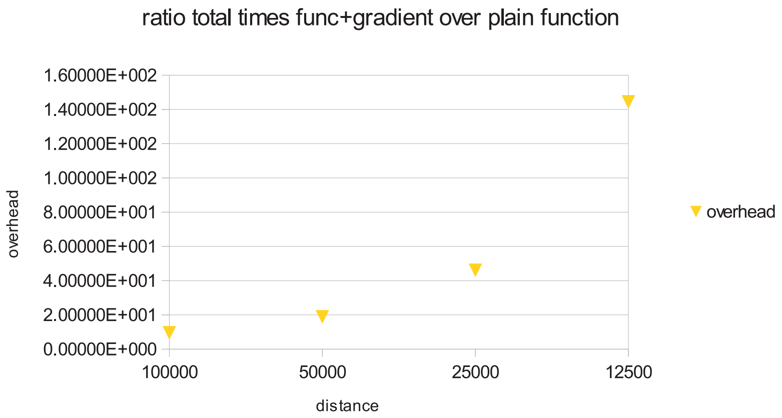

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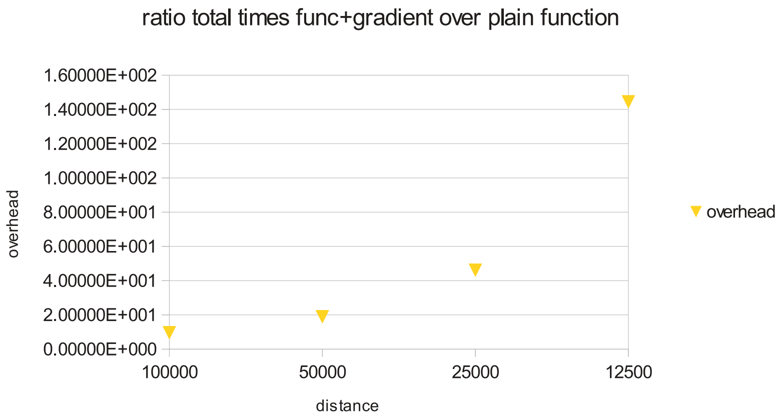

i.e. pretty nasty ... BUT

AdolC-ified ISSM performance - outlook

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